Form No. 7250
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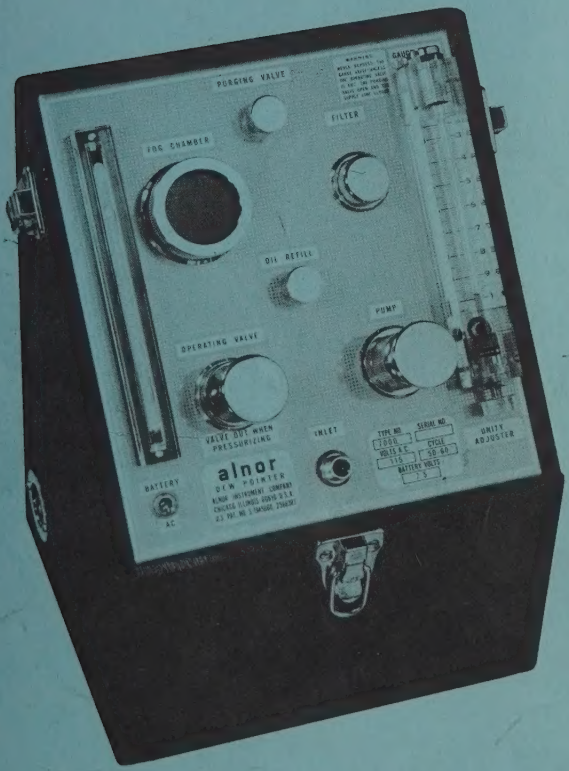
INSTRUCTIONS FOR ALNOR TYPE 7000 DEW POINTER



ALNOR®
INSTRUMENT COMPANY
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NILES, ILLINOIS 60648
(312) 647-7866 • TELEX 72-4458

INSTRUCTIONS FOR
ALNOR TYPE 7000 DEW POINTER

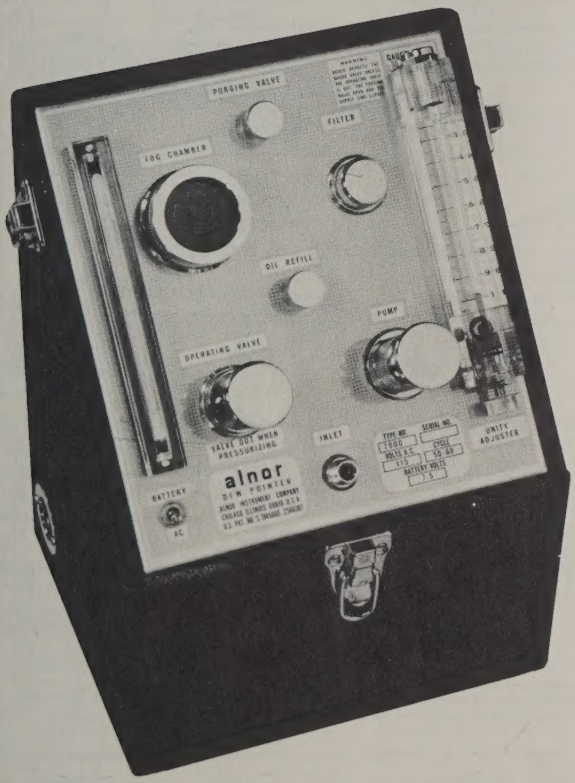

FIG. 1

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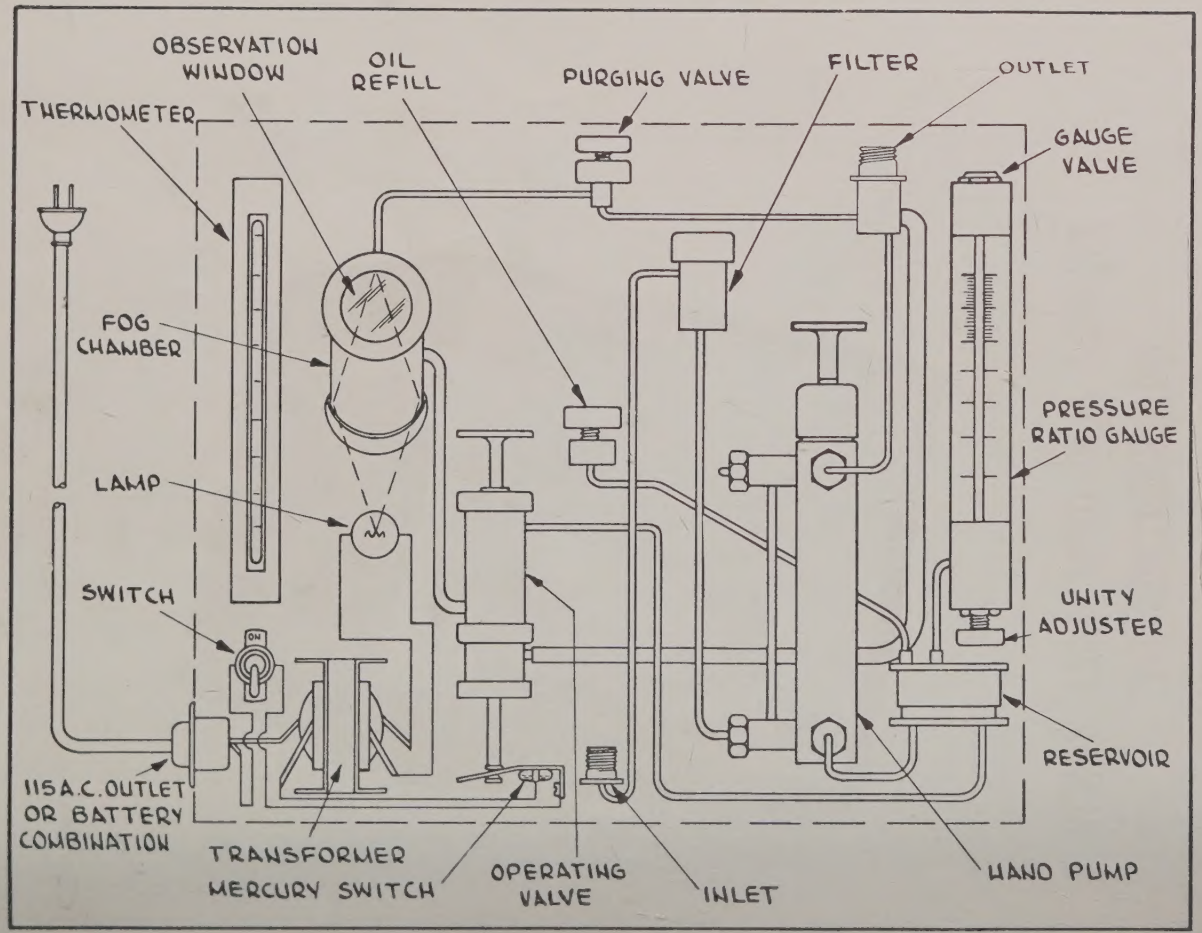

SCHEMATIC DIAGRAM

FIG. 2

INSTRUCTIONS FOR "ALNOR" TYPE 7000 DEW POINTERS

Introduction

The Alnor Dew Pointer is used to determine the dew point of a gas-water vapor mixture. When a gas-water vapor mixture is cooled there is some temperature at which water will begin to condense out. By definition this temperature is known as "Dew Point".

As a sample of a gas-water vapor mixture is cooled, its relative humidity is increased. If the sample is cooled sufficiently the relative humidity will reach 100% – i.e. the sample will be "saturated". Any further cooling will result in the precipitation of water. Therefore the saturation temperature and the dew point temperature are identical values.

Dew Point is a convenient way of determining and expressing the absolute humidity of air and other gases.

The 7000 instrument is available in three nominal dew point ranges as follows:

TYPE	NOMINAL DEW POINT RANGE
7000H	Room Temp. to - 20°F.
7000U	Room Temp. to - 80°F.
7000L	0°F. to - 80°F.

The actual range of each instrument is dependent on the temperature of the Dew Pointer and the gas being tested in addition to the range of the pressure ratio gauge.

The convenience, portability, accuracy, reproducibility (several different operators can easily get the same results) and freedom from the use of external coolant, make the instrument highly desireable.

Connections

If A.C. power is to be used connect the Dew Pointer to a convenient 50 or 60 Hz. source of the voltage indicated on the name plate by means of the cable provided.

Connect the source of gas to the inlet (bottom center) of the meter. Copper connecting tubing is most desireable (sweat the copper tubing to the fitting supplied), although a dense neoprene tubing may be used for dew points above -20 F. Ordinary rubber tubing may cause large errors. **All Connections Must Be Tight.**

If the source of gas is at a pressure appreciably above atmospheric pressure a shut off valve should be provided in the inlet line. In dirty gas, the external filter must be used.

The outlet of the Dew Pointer (rear) may be connected to a suitable waste line if desired. See note 11 on page 7.

Adjustments

Before operating the Dew Pointer, a Unity Adjustment must be made on the Pressure Ratio Gauge as follows:

1. Place operating valve in out position.
2. Open Purging Valve to be sure there is no pressure in the instrument.
3. Depress the Gauge Valve and turn the Unity Adjuster until the bottom of the meniscus is in line with the 1 mark.
4. Release the Gauge Valve.

Close the purging valve and pump up the instrument until the pressure ratio gauge reads about .5. Open the purging valve. If the meniscus does not return to the 1 mark after a few moments, repeat the unity adjustment as above. It sometimes happens that after a period of prolonged idleness the flexible diaphragm in the oil reservoir takes a set, but the above operation will correct the condition.

If the source of gas is above atmospheric pressure be sure to shut off the source of pressure before making the unity adjustment.

WARNING: Never depress the gauge valve unless the operating valve is out and the purging valve open, and the supply valve closed.

The unity adjustment should be checked frequently-particularly if the instrument temperature or barometer pressure is fluctuating.

Operation

Open the purging valve. Pull out the operating valve.

Place switch in "A.C." or "B" (for battery) according to the power source to be used.

Pump the gas to be tested thru the instrument to flush out all the old gas in the Dew Pointer (at least 10 to 15 strokes of the pump). When very low dew points are to be tested more thorough purging is required. The Dew Pointer will give the correct dew point of the sample in the instrument. Be sure to flow enough gas thru so that the gas in the instrument is the gas you want to test.

When the gas is generated under pressure, permit this pressure to force the gas

thru the instrument to perform the purging operation, and minimize the pumping.

Close the purging valve. Pump a sample of gas in the instrument. Look into the observation window and press down on the operating valve.

Depressing the operating valve actually performs three operations in the following sequence.

1. Closes line from the inlet and pressure ratio gauge.
2. Turns on the light.
3. Rapidly opens the line from fog chamber to the atmosphere.

If a fog (cone of sunbeams) appears, it indicates the gas was cooled below the dew point and subsequent trials should be made at lower pressures (numerically higher pressure ratios). Make similar trials at each higher major division on the pressure ratio gauge until one reading is obtained where no fog appears. Then "Close In" on the end point, i.e. maximum pressure ratio that will produce a fog.

The object of the operation of the Dew Pointer is to determine the pressure ratio that will just produce a fog. This is called the "End Point".

If on the first trial no fog appears, it indicates that the gas was not cooled down to the dew point. It is apparent, therefore, that a lower pressure ratio (higher pressure) is required to produce sufficient cooling to reach the dew point. Subsequent trials should, therefore, be made at each lower (higher pressure) major division on the Pressure Ratio Gauge until one trial is obtained in which a fog appears. Having located one point where there is a fog and one where there is no fog, "close in" on the end point. It is easily possible to get the difference between the appearance and non-appearance of the fog to be only .01 apart, as read on the pressure ratio gauge.

After any trial in which a fog appears, it is advisable to take several strokes on the pump to purge the fog chamber of any droplets of moisture that fail to re-evaporate promptly.

When making the last trials near end point, permit 10 to 15 seconds to lapse after pumping the sample into the instrument before pushing down the operating valve to permit the sample to come to the temperature of the fog chamber.

The experienced operator will find he can determine the end point after a few trials since the density of the fog on any given trial is a valuable clue to how far he is from the end point.

If the approximate value of the dew point is known, the reverse operation of the Dew Point Calculator will indicate the approximate Pressure Ratio which should be used for the initial trial. This will further reduce the number of trials required to achieve the end point.

After determining the end point, take the mean between the minimum pressure ratio that fails to produce a fog and the maximum pressure ratio that produces a fog. Use this value with the initial temperature as read on the thermometer and the Q value for the gas being tested to compute the dew point with the "Alnor" Dew Point Calculator.

Q Values

The Q value of a gas is a natural constant of the gas. It is representative of the cooling power of the gas.

The Q value of the gas being tested must be known to arrive at the dew point of the gas. Values of common gases are given below.

TABLE 1

		Q
Air		.285
Argon	A	.400
Carbon Dioxide	CO_2	.225
Carbon Monoxide	CO	.285
Dissociated Ammonia		.285
Endothermic		.285
Ethane		.165
Exothermic		.285
Helium	He	.400
Hydrogen	H_2	.285
Methane	CH_4	.240
Nitrogen	N_2	.285
Oxygen	O_2	.285
Propane		.139
Other Gases	Refer to chemical Handbooks	
Gas Mixtures	Refer to the Appendix.	

Use Of The Dew Point Calculator

To use the Dew Point Calculator Form No. 7230B, the following values must be known.

1. Q value of the gas.
2. The initial temperature of the gas as read on the thermometer on the Dew Pointer.
3. The pressure ratio required to just produce a fog.

When "Q" Value is 0.2855

Set arrow 1 at initial temp., °F or °C, on Scale E.
Opposite the observed pressure ratio on Scale D, read Dew Point on Scale E.

EXAMPLE: Air is being tested so the Q value is .2855. The thermometer reads 75°F. A fog appears at a pressure ratio of .46, but does not appear at .47, therefore, the end point is .465.

1. Set the arrow "1" opposite 75 on scale "E".
2. Opposite .465 in scale "D", read the dewpoint temperature of -30°F, on the scale "E".

When "Q" Value is not 0.2855

Set arrow 1 at initial temp., °F or °C, on Scale E.
Set arrow 2 at "Q" value on Scale A.
Opposite the observed pressure ratio on Scale B, read Equivalent pressure ratio on Scale C.
Opposite the Equivalent pressure ratio on Scale D, read the Dew Point on Scale E.

EXAMPLE: Pure methane is being tested. The Q value is .24. The initial temperature is 80°F. A fog appears at .51 but does not appear at .52 so the end point is .515.

1. Set arrow "1" at 80°F on Scale E.
2. Set arrow "2" at .24 on Scale A.
3. Opposite .515 on Scale B, read Equivalent pressure ratio as .57 on Scale C.
4. Opposite the Equivalent pressure ratio .57 on Scale D, read Dew Point as 0°F on Scale E.

NOTE: See Appendix for use of the older Calculators, Forms 7230 & 7230A.

Principle Of Operation

The principle of operation of the Dew Pointer is fundamental and simple. A thorough understanding of this principle will aid in the operation of the instrument.

The gas to be tested is pumped into the observation chamber at some pressure above atmospheric. The chamber is then rapidly exhausted to the atmosphere with a resultant expansion and cooling of the gas. If the cooling is sufficient to reduce the temperature of the gas to, or below, the dew point, water vapor will condense out in the form of a fine mist or fog. This fog is readily observable thru the observation window. Because of a light located below the fog chamber focused at the top of the chamber, the fog appears as a cone of sunbeams.

Successive trials will determine the minimum initial pressure which will produce a fog. The gas is then being cooled just to the dew point. The final temperature after expansion (the dew point) which is maintained for too brief an interval to measure, is then computed by means of the equation for an adiabatic expansion. The expansion is adiabatic (no heat added or subtracted during the process) because it is so rapid.

The following equation expresses a fundamental relationship between the pres-

sure and temperature during an adiabatic expansion.

$$\text{Final Temp.} = \text{Initial Temp.} \left[\frac{\text{Final Pressure}}{\text{Initial Pressure}}\right]^{\frac{K-1}{K}}$$

where all values are in absolute units and

$$K = \frac{\text{specific heat at constant pressure}}{\text{specific heat at constant volume}}$$

For the "Alnor" Dew Pointer, the final temperature is the dew point temperature ($t_{D.P.}$). The ratio (P.R.) between the final pressure and initial pressure can be read directly on the pressure ratio gauge without necessity of knowing the individual quantities. By definition $Q = \frac{K-1}{K}$

The equation for an adiabatic expansion can, therefore, be converted into the following form for our purpose

$$t_{D.P.} = (t_i + 460)\,(P.R.)^{Q} - 460$$

when the temperatures are in ° F.

Since the initial temperature (t_i) is read on the thermometer, P. R. is read on the pressure ratio gauge, and Q is a constant that depends on the gas being tested, it is apparent that the solution for the dew point temperature ($t_{D.P.}$) is perfectly straightforward though somewhat cumbersome. In actual use, a calculator is supplied that makes the above computation extremely simple.

The formation of a visible fog at the dew point temperature depends on the presence of dust in the gas to act as nuclei around which the droplets can form. In practically all cases dust is present. If, however, gas is completely dust free (such as gas produced by fractional distillation) it would be possible to cool the gas below the dewpoint temperature without condensing the moisture, if some substitute for the dust particles were not provided. All ALNOR Dew Pointers are therefore equipped with a piece of radioactive material built into the fog chamber. The radiation ionizes the gas in the chamber and the ions act as nuclei around which the droplets can form and build up to visible size. These Dew Pointers will, therefore, give the correct result regardless of the presence or absence of dust.

Operating Notes

1. When working with dry gases having low dew points, it should be remembered that extremely small quantities of water vapor are involved. It should further be remembered that the instrument can only give the result for the gas sample that is actually in the fog chamber. It is for this reason that it is extremely important that the gas does not pick up or lose moisture in the process of being transferred from its source to the fog chamber.

2. Copper tubing is the most satisfactory material for connecting the instrument to the source of gas because it is not hygroscopic. The use of rubber tubing will almost certainly contaminate the gas sample. A dense neoprene or vinyl tubing is satisfactory except for very dry gases.

It is for the same reason that the filter material should be replaced occasionally.

If an appreciable quantity of dust is allowed to accumulate in the filter, the moisture content of the gas may be altered as it passes through the filter.

3. The built in hand pump is double acting. The gas flowing on the top side of the piston is discharged through the outlet without flowing through the fog chamber.

4. The only function of this gas is to keep the pump barrel dry and avoid contamination of the test gas.

5. Thorough initial purging of the instrument is important. Reference to the vapor density curves (figs. 7 & 8) show that the vapor density at 50° F. is .59 lbs. per 1000 cu. ft. and the vapor density at -70° F. is only .0019 lbs. per 1000 cu. ft. If the instrument were originally filled with air having a dew point of 50° F. and only .1% of the original volume were left in the chamber due to inadequate purging the instrument would give an indication that was 3° high when testing a sample of gas having a dew point of -70°F.

6. It is, of course, important to have all connections tight on the inlet side of the instrument. In some cases momentary negative pressures can be caused in the inlet line by the operation of the hand pump. If there were a leak in the inlet line atmospheric air could flow in and add moisture to the sample during these short periods of negative pressure. Furthermore, the vapor pressure of the air is generally higher than the vapor pressure of the gas being tested. It is, therefore, possible for water vapor to flow in through a leaky connection even when the gas pressure is above atmospheric.

7. If the gas is drawn from a high pressure, as from a bottle of compressed gas, a pressure reducing valve or a needle valve will be needed ahead of the Dew Pointer. A connecting line of adequate

size is needed (¼" copper tubing is suggested). Do not use capillary tubing. Do not use an extremely high rate of flow during purging. The use of an excessive flow rate or the use of capillary tubing may cause moisture to be removed from the gas before it enters the Dew Pointer.

8. The above caution does not imply that the flow rate during purging is extremely critical. If the flow rate is such that the oil in the pressure ratio gauge is between .95 and .98 it will be quite satisfactory.

9. The flow rate must, of course, be great enough to back up the hand pump. The pumping action should not pull an appreciable vacuum on the inlet line.

10. Notice that there is a by-pass around the fog chamber thru the top side of the pump. If there is pressure on the inlet side of the Dew Pointer it is quite normal to have a continuous flow from the instrument.

11. If a hazardous or noxious gas is being used it is permissible to connect a discharge line to the outlet of the Dew Pointer. It should be of ample size so that the pressure at the outlet is essentially atmospheric. Do not use a gas that will attack brass or copper.

12. A sample may be drawn from a furnace if the dew point of the sample is lower than the temperature of the Dew Pointer. A ¼" O.D. Inconel tube is suggested for sampling in a furnace. A five foot soft copper extension will aid in cooling the sample.

RADIOACTIVE MATERIAL

As mentioned on page 6, an ionization source is located inside the fog chamber of each Dew Pointer to provide nuclei around which droplets can form. This source can be described as a "fixed sealed source containing 6¼ microcuries of Ra 226".

The legislatures of some of our States have passed bills to protect the people within their States from the indiscriminate use of radio-active materials. In general, these laws may require licensing or registration of the user and impose certain regulatory requirements which must be met.

It is advised that the State radiological health agency be contacted to ascertain what laws may be in effect regarding the possession and utilization of this detector.

While the amount of radioactive material in this instrument is small and represents little hazard to the user, compliance with local requirements helps insure continuing accountability of radioactive materials in the State.

SERVICE NOTE

Disassembling the fog chamber should not be attempted without specific authority from your State radiological health agency.

Q Value Of Mixtures

A mixture of gases can be treated as a single gas if the proper constants are established. The value of Q can be computed by one of the following methods.

METHOD 1 - MASS BASIS

Since the effect that the specific heat of an individual gas has on the specific heat of the mixture is proportional to the mass of the gas present the following equation can be written.

$$(1)\ C_{pm}=\frac{M_x}{M_m}C_{px}+\frac{M_y}{M_m}C_{py}+\text{----}+\frac{M_z}{M_m}C_{pz}$$

$$(2)\ C_{vm}=\frac{M_x}{M_m}C_{vx}+\frac{M_y}{M_m}C_{vy}+\text{----}+\frac{M_z}{M_m}C_{vz}$$

Where

C_{pm} = Specific heat at constant pressure of the mixtures

C_{vm} = specific heat at constant volume of the mixture

C_{vx}, C_{vy}, & C_{vz} = specific heat at constant volume of each gas.

C_{px}, C_{py}, & C_{pz} = specific heat at constant pressure of each gas.

M_m = total weight of the mixture

M_x, M_y & M_z = weight of each gas

Specific heats are expressed in heat units per weight unit per temperature unit such as B.T.U. per pound per ^{o} F.

Then

$$(3)\ K_m=\frac{C_{pm}}{C_{vm}}$$

and

$$(4)\ Q_m=\frac{K_m-1}{K_m}$$ or from figure 3

where

K_m = K value for the mixture

Q_m = Q value for the mixture

It is only necessary to insert the proper values in equations (1) and (2) and then solve.

EXAMPLE FOR METHOD 1

A mixture of gas is known to be composed of the following:

20% by weight CH_4
40% by weight CO_2
40% by weight N_2

Find the value of Q

Substituting in equations 1 and 2

C_{pm} = .2 (.593)+.4 (.200)+.4 (.247)=.2974

C_{vm} = .2 (.450)+.4 (.155)+.4 (.176)=.2244

Then

$$K_m=\frac{.2974}{.2224}=1.337$$

and

$$Q_m=\frac{.337}{1.337}=.252$$

METHOD 2 - VOLUMETRIC BASIS

When a mixture of gases is analyzed with an Orsat apparatus the percentages of each component are determined on a volumetric basis. It is, therefore, essential that these volumetric percentages be converted to weight percentages before Method 1 can be used.

$$(5)\ \frac{M_x}{M_m}=\frac{Xd_x}{d_m}\qquad \frac{M_y}{M_m}=\frac{Yd_y}{d_m};\ \text{etc.}$$

where

X = percent by volume of gas X

d_x = density of gas X

d_m = density of the mixture

Notice that any condition of temperature and pressure and any units of density can be used provided the same conditions and units are used thruout.

Equations 1, 2, 3, & 5 can be combined and multiplied by $\frac{d_m}{d_m}$ to following simple form.

$$(6)\ K_m=\frac{Xd_xC_{px}+Yd_yC_{py}+\text{---}+Zd_zC_{pz}}{Xd_xC_{vx}+Yd_yC_{vy}+\text{---}+Zd_zC_{vz}}$$

Where X, Y and Z are volumetric percentages of each gas and d_x, d_y, and d_z are the density of each gas.

Since the values of d_xC_{px} are presented in Table 4 the solution of Equation 6 is extremely simple. Q can be obtained from Figure 3. Because of similarity of values CO, O_2, H_2, and N_2, can be considered one gas.

K TO Q CONVERSION CURVE

FIG. 3

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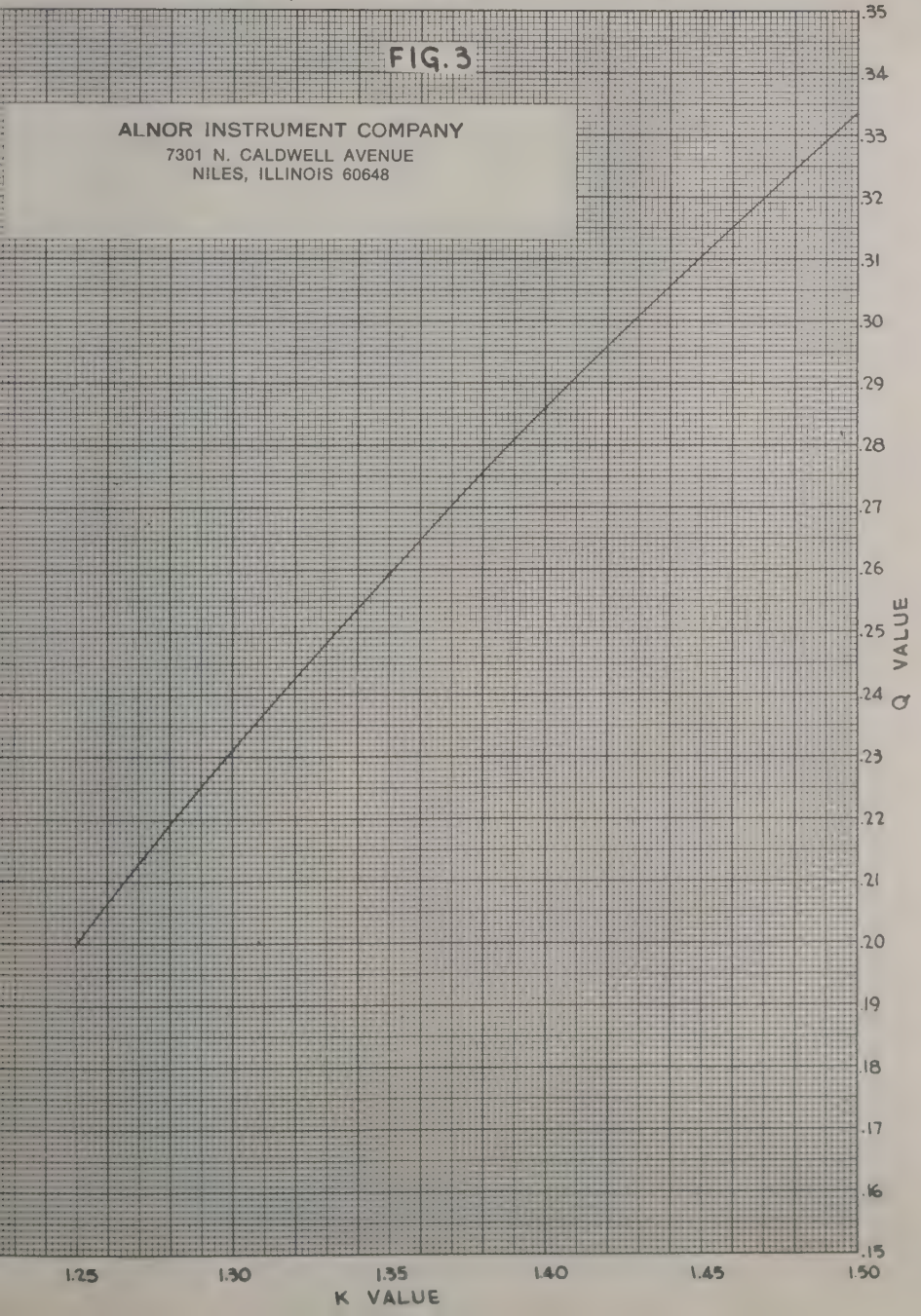


TABLE 4

Gas	Density lbs/c.f. @62° F.	C_p B.T.U. per lb.	C_v B.T.U. per lb.	$(d)C_p$ B.T.U. per c.f.	$(d)C_v$ B.T.U. per c.f.	K	Q
CO	.0735	.245	.175	.0180	.0128	1.40	.2855
N_2	.0737	.247	.176	.0182	.0130	1.40	.2855
O_2	.0840	.217	.155	.0182	.0130	1.40	.2855
Air	.0757	.241	.171	.0182	.0130	1.40	.2855
H_2	.00529	3.42	2.44	.0181	.0129	1.40	.2855
CO_2	.1156	.200	.155	.0231	.0179	1.29	.225
CH_4	.0421	.593	.450	.0250	.0190	1.315	.240
He	.01114	1.25	.7530	.0139	.0084	1.660	.400
A	.11135	.125	.0751	.0139	.0084	1.668	.400

Notice that all diatomic gases listed can be treated as a single gas for all practical purposes.

EXAMPLE FOR METHOD 2

A mixture of gases is known to consist of the following:

72% by volume N_2

12.5% by volume of H_2

10% by volume of CO

5% by volume of CO_2

.5% by volume CH_4

Find the value of Q

Substituting in equation 6

Gas	Numerator	Denominator
N_2	.72 (.0182) = .01310	.72 (.0130) = .00936
CO	.10 (.0180) = .00180	.10 (.0128) = .00128
CO_2	.05 (.0231) = .00116	.05 (.0179) = .00090
H_2	.125 (.0181) = .00226	.125 (.0129) = .00161
CH_4	.005 (.0250) = .00013	.005 (.0190) = .00010
	.01845	.01325

$$K_m = \frac{.01843}{.01325} = 1.392 \qquad Q_m = .281$$

METHOD 3 - CURVES

A great many commonly used mixtures primarily consist of only one gas other than diatomic gases. For these mixtures values of Q can be picked off of the curves in Figure 4.

The curves in Figure 4 are plotted for mixtures which consist of percentages of the gas named where the balance of the mixture is N_2, O_2, H_2 or CO. If small percentages of other gases are present, they can be ignored.

EXAMPLE - METHOD 3

Given the mixture specified for the example of Method 2 find the value of Q by use of Figure 4.

Since the values of d (C_p) and d (C_v) are so nearly equal for all the diatomic gases assume that they are actually one gas having the characteristics of N_2. Since the volume of CH_4 is small add it to the CO_2 for this purpose, then the analysis of the gas becomes

5.5% by volume CO_2

94.5% by volume N_2

From Figure 4 Q = .281

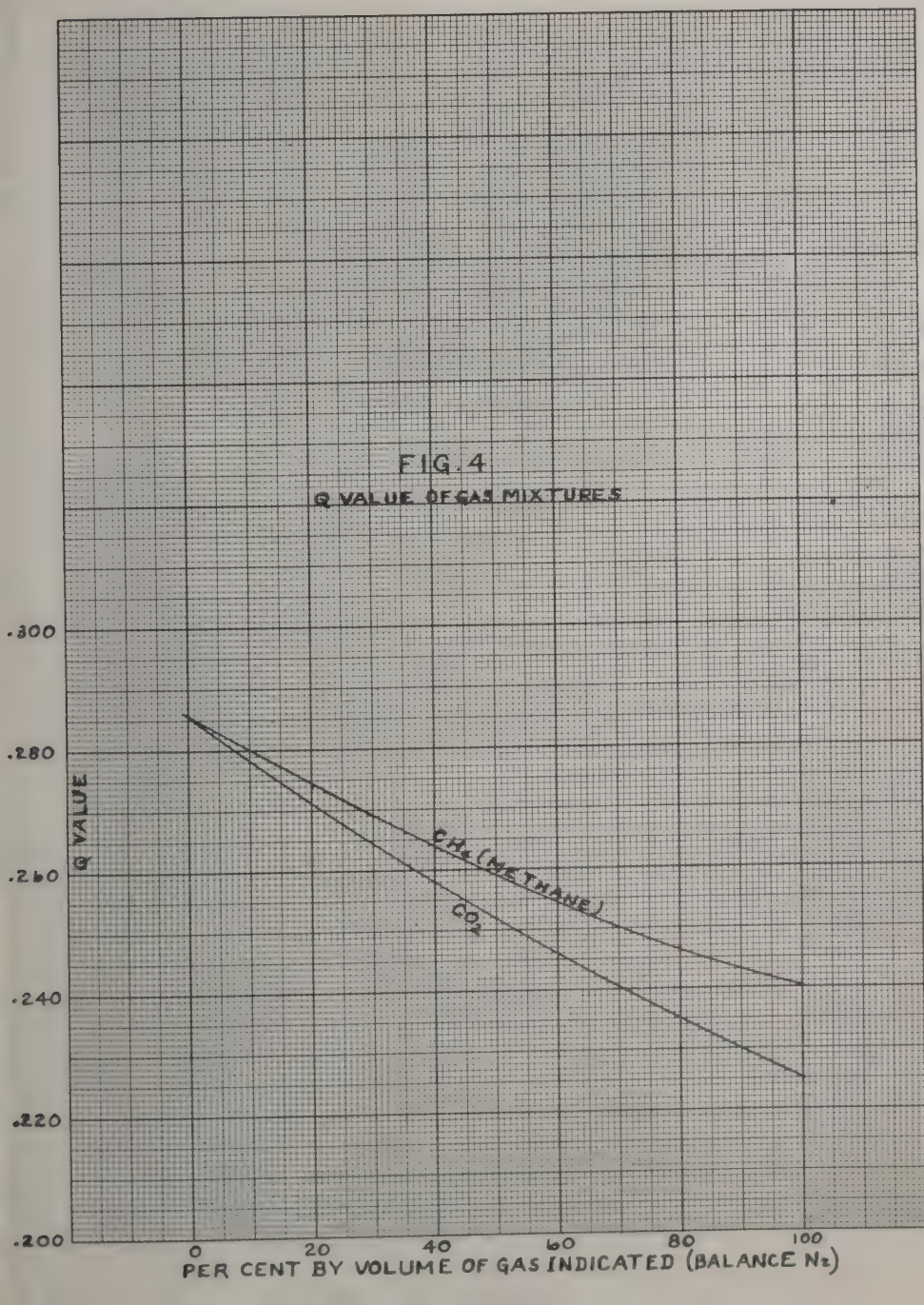


FIG. 4
Q VALUE OF GAS MIXTURES
.300
.280
.260
.240
.220
.200
Q VALUE
CH_4 (METHANE)
CO_2
0
20
40
60
80
100
PER CENT BY VOLUME OF GAS INDICATED (BALANCE N_2)

ACCURACY OF GAS ANALYSIS

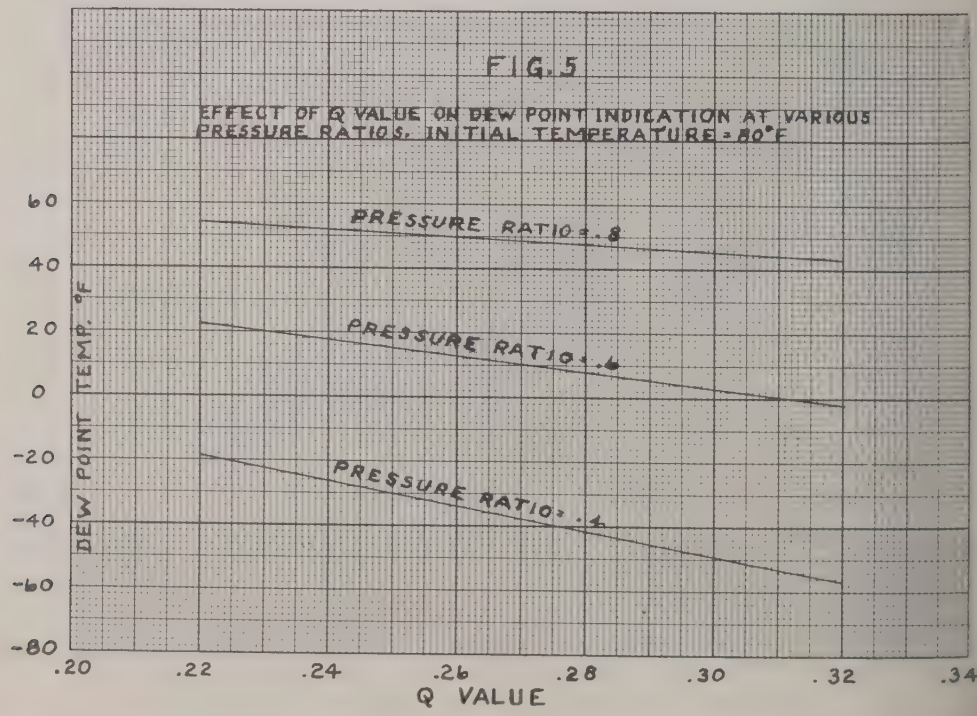
An error of .005 in the Q value will produce an error of approximately 2° F. when the pressure ratio is .4; the error will be less for higher pressure ratios. It is, therefore, apparent an error of about 10% in the volumetric analysis of CH_4 or about 7% in the volumetric analysis of CO_2 is generally permissible. It is, therefore, evident that the "Alnor" Dew Pointer is not dependent upon an accurate gas analysis as far as common mixtures are concerned. It is obviously not necessary to make an Orsat analysis prior to each dew point test.

Figure 5 graphically shows the effect of Q value in the dew point determination assuming an initial temperature of 80° F. For comparatively high dew points (above 0° F.) this value is far from critical. For lower dew points the value of Q should be known with greater accuracy.

VAPOR DENSITY AND VAPOR PRESSURE

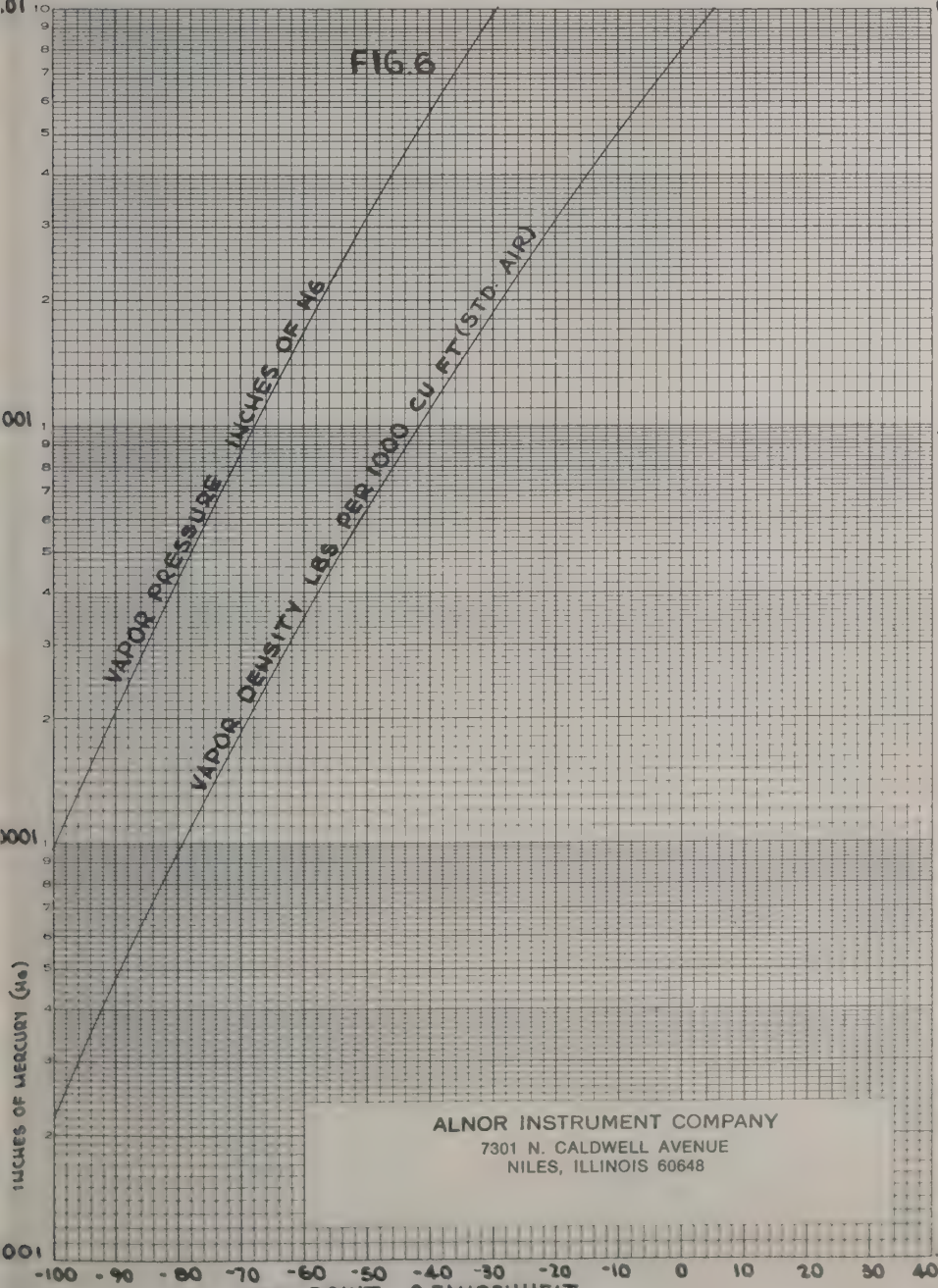
For each dew point there is a corresponding water vapor pressure and water vapor density. The "Alnor" Dew Pointer might just as well have been named a "Vapor Pressure Tester" or "Vapor Density Gauge". The following curves have been provided to permit easy transfer from one set of values to another as the need arises.

For dew points below freezing there are theoretically two possible values for vapor pressure, that is, vapor pressure over ice or vapor pressure over water. There is considerable experimental evidence indicating that the vapor pressure of air corresponds with the vapor pressure of sub-cooled water, whether the air is actually in contact with sub-cooled water or with ice. Accordingly the vapor pressures plotted on the following curves correspond with the vapor pressures over sub-cooled water. Vapor densities are plotted on the same basis.



VAPOR PRESSURE AND VAPOR DENSITY CURVES

FIG. 6



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VAPOR PRESSURE AND VAPOR DENSITY CURVES

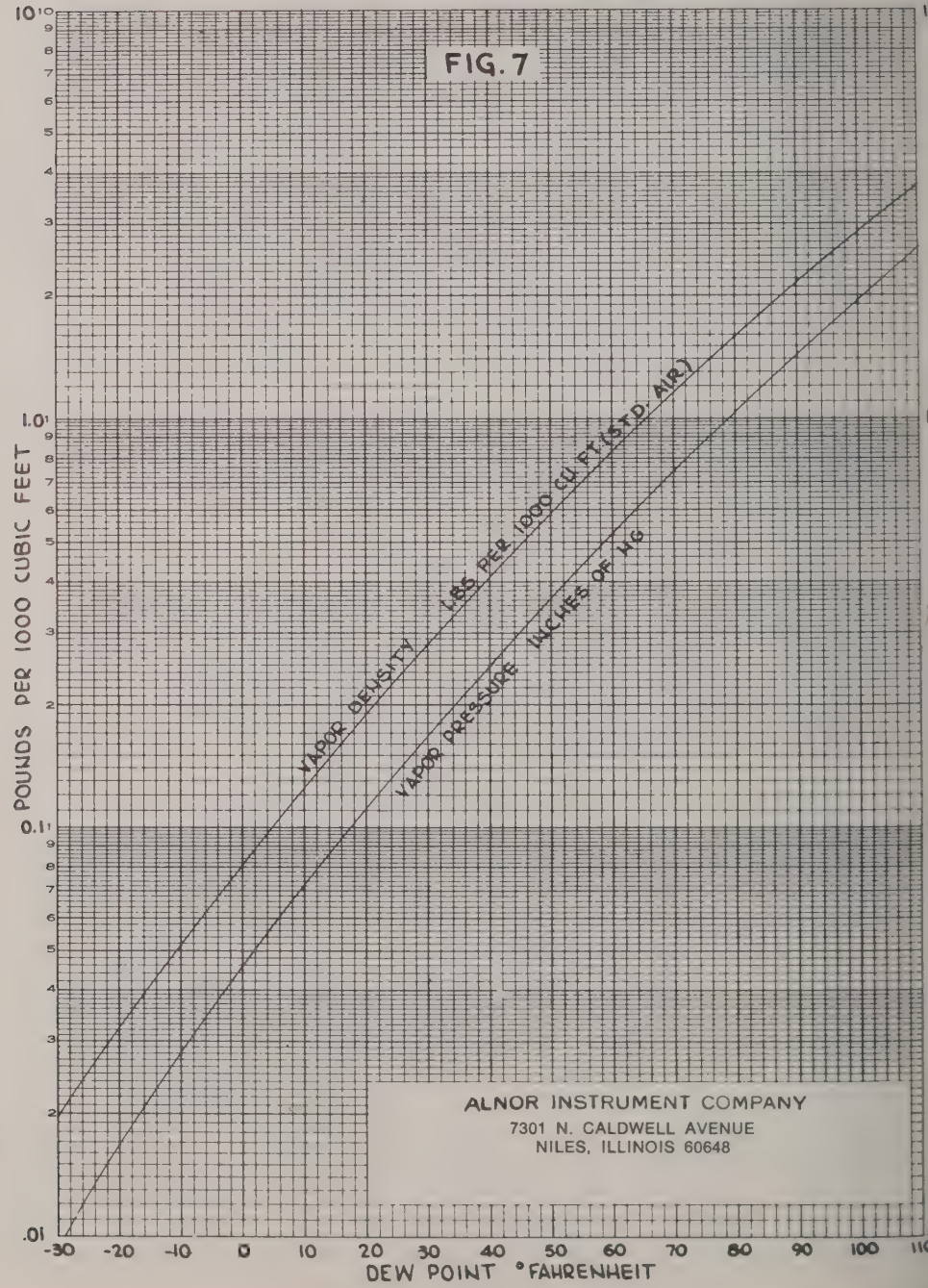
FIG. 7
VAPOR DENSITY LBS. PER 1000 CU. FT. (STD. AIR)
VAPOR PRESSURE INCHES OF HG
POUNDS PER 1000 CUBIC FEET
INCHES OF MERCURY (Hg)
10
1.0
0.1
.01
-30 -20 -10 0 10 20 30 40 50 60 70 80 90 100 110
DEW POINT °FAHRENHEIT
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THE DEW POINTER AS A "GO, NO-GO GAUGE"

For shop use it is frequently desirable to use the Dew Pointer as a Go, No-Go Gauge. In this case the operation of the instrument becomes so simple that comparatively unskilled workmen can use it.

As an example assume a situation where a gas having a Q value of .2855 is carried in a pipe line at 1 pound gauge pressure. The process is to be operated so that the dew point is kept below 0° F. By performing the operations in reverse order the Dew Point Calculator can be used to develop a chart as follows:

1. Set arrow 1 at initial temperature on Scale E.
2. Opposite max. Dewpoint (Scale E) read pressure ratio (Scale D).

FOR 0° F. DEW POINT

Q .2855

Thermometer	Pressure Ratio Gauge
70	.61
72	.60
74	.59
76	.583
78	.577
80	.57

The instrument can be left connected to the gas line continously with the purge valve cracked so that a small amount of gas is bleeding thru continously. Thus no additional purging would be required. All the operator would have to do is read the thermometer - close the purging valve - pump the instrument up to the indicated pressure ratio - pause for fifteen seconds - and press the operating valve. If a fog appears the dew point is above 0° F.

DEW POINTS AT ELEVATED PRESSURES

If a sample of gas is compressed it is apparent the vapor pressure is increased. The compressed gas, therefore, has a higher dew point that corresponds to the new vapor pressure.

The "Alnor" Dew Pointer gives the dew point at atmospheric pressure. When the corresponding dew point at higher pressures is required refer to Figure 8.

Example: A gas is carried in a pipe line at 585 pound gauge pressure. The "Alnor" Dew Pointer indicates the dew point is -65° F. What is the actual dew point in the pipe line.

Answer is 1° F.

PSYCHROMETRIC CHART

Figure 9 shows the relationship between dew point temperatures, dry bulb temperatures, and relative humidity in the low humidity regions which are difficult to to read on the usual psychrometric chart. The "Alnor" Dew Pointer is particularly useful for making humidity measurements in this comparatively dry region.

Relative humidity is by definition the ratio of the actual vapor pressure of water vapor (the saturated vapor pressure at the dew point) in an air-vapor mixture to its saturated vapor pressure at the dry bulb temperature.

Relative humidity may also be defined as ratio of the weight of water vapor in one cubic foot of the mixture as indicated by its dew point, to the weight of water vapor in one cubic foot of a saturated mixture at the dry bulb temperature.

Example: Dry Bulb Temperature 80° F.
Dew Point Temperature 0° F.

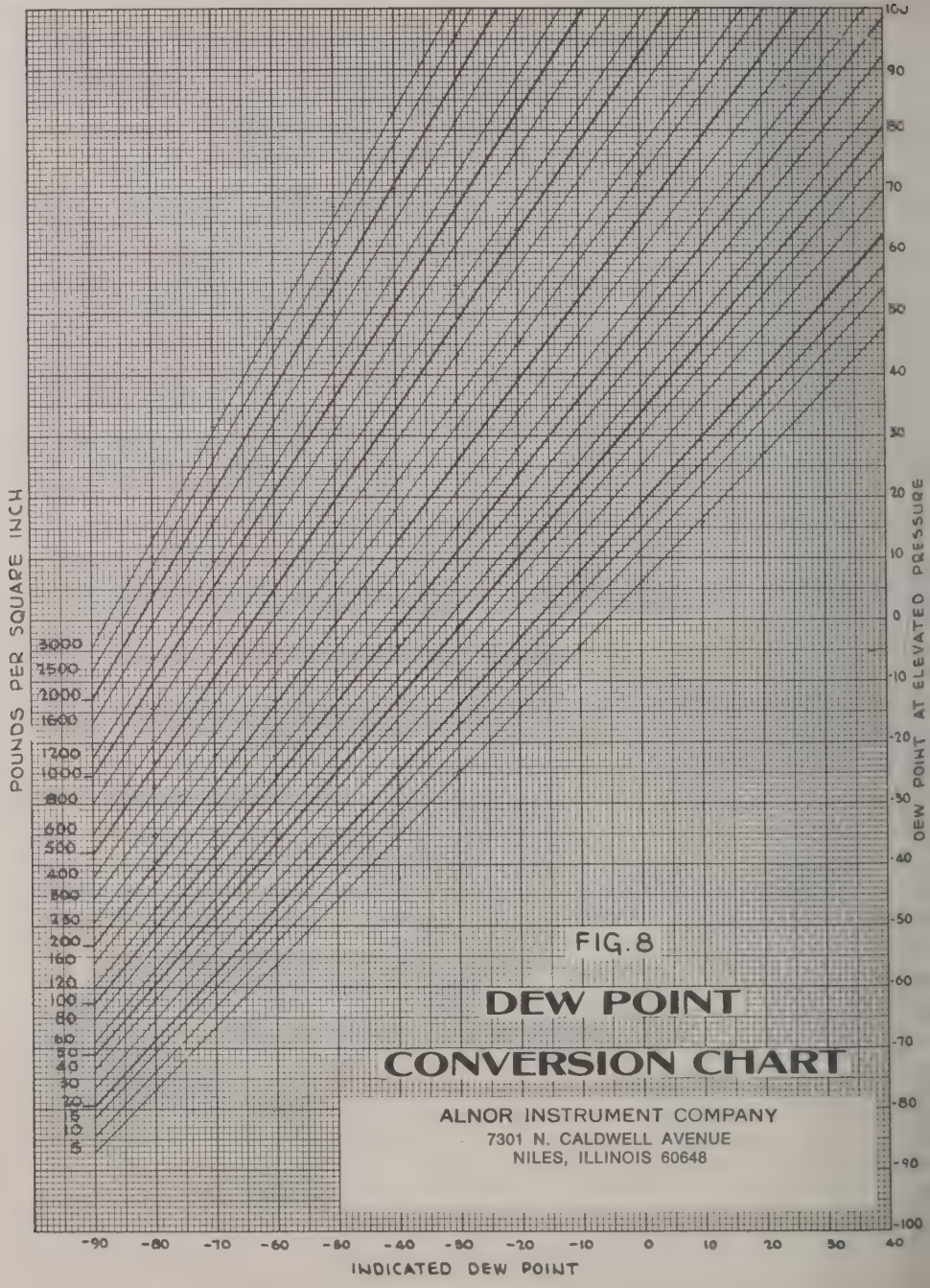
What is the Relative Humidity?
Answer from Figure 9 4.4%

Figure 10 is a standard Psychrometric Chart. In addition to dew point temperatures, dry bulb temperatures and relative humidity, it shows wet bulb temperatures, grains of water vapor per cubic foot, grains of water vapor per pound of dry air and the volume of the mixture in cubic feet of mixture per pound of dry air.

Example: Dry Bulb Temperature 90° F.
Dew Point Temperature 50° F.

What other values can be read from the Psychrometric Chart?

Answer: Wet Bulb Temperature 65° F.
Relative Humidity 25%.
Volume of the Mixture 14.0 per cu. ft. of dry air.
Density of the vapor 4.11 grains per cu. ft.
Weight of the vapor 53.4 grains per lb. of dry air.


POUNDS PER SQUARE INCH
3000
2500
2000
1600
1200
1000
800
600
500
400
300
250
200
160
120
100
80
60
50
40
30
20
15
10
5
-90 -80 -70 -60 -50 -40 -30 -20 -10 0 10 20 30 40
INDICATED DEW POINT
DEW POINT AT ELEVATED PRESSURE
90
80
70
60
50
40
30
20
10
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
-100
FIG. 8
DEW POINT
CONVERSION CHART
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PSYCHROMETRIC CHART

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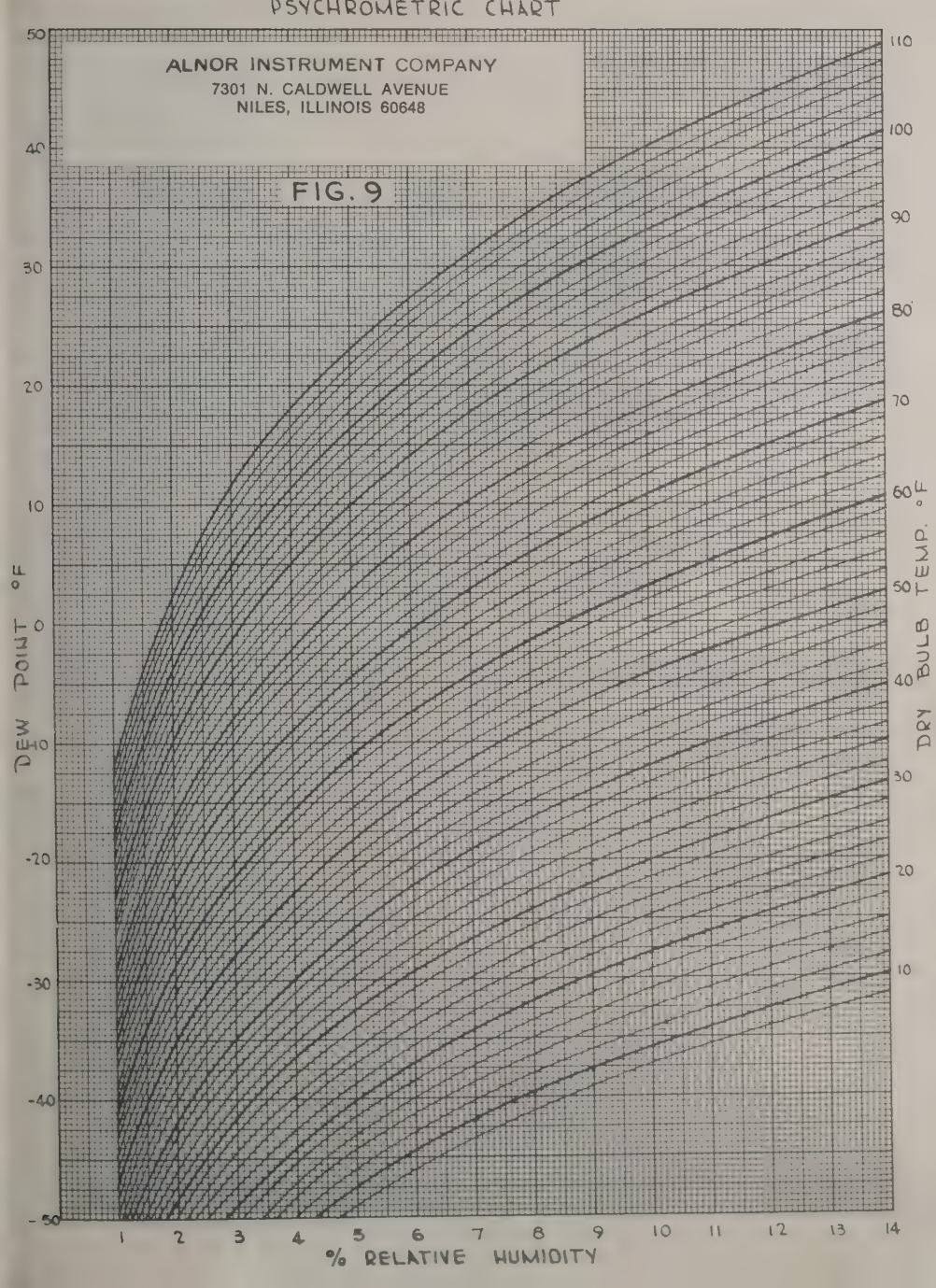
FIG. 9



PSYCHROMETRIC CHART

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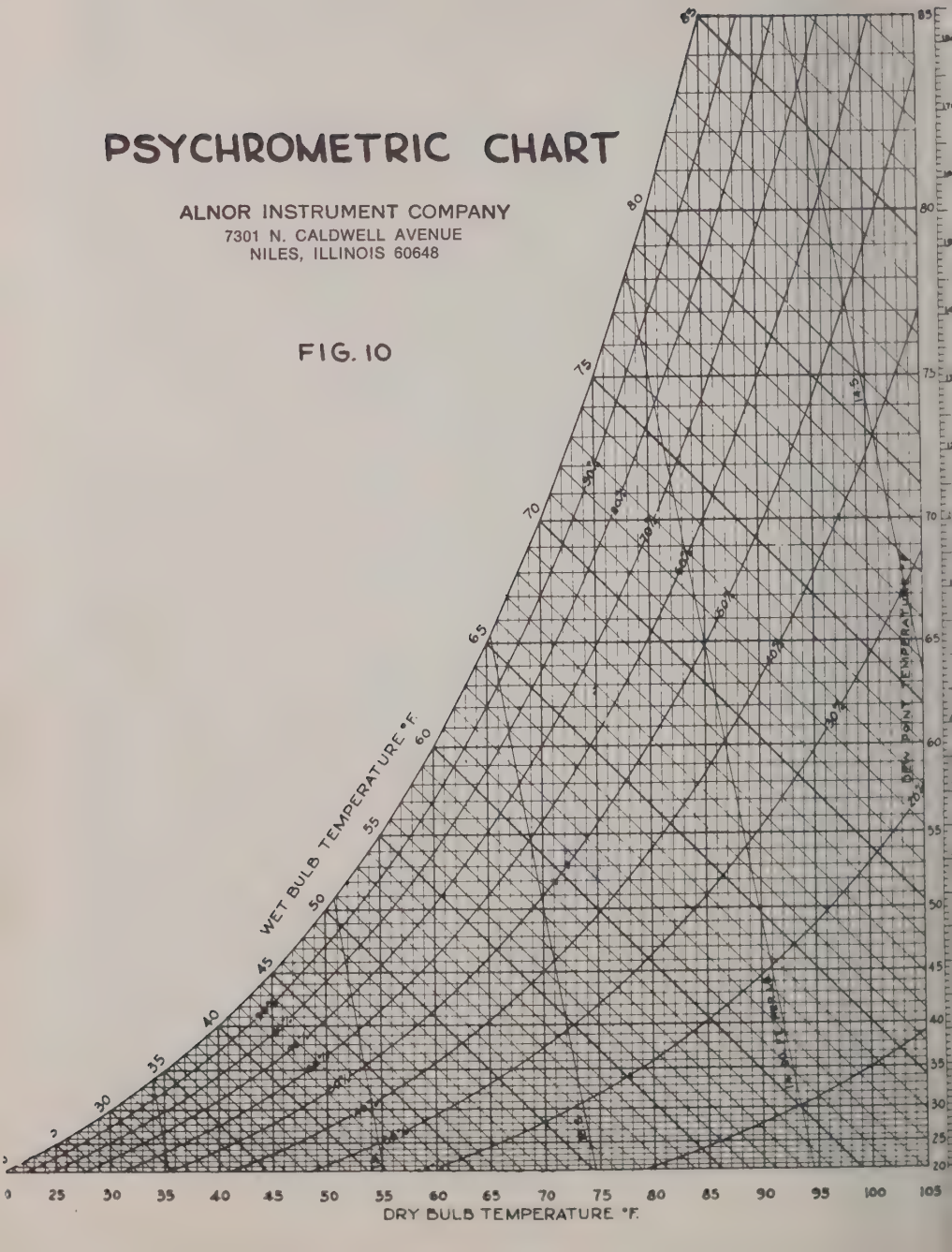
FIG. 10



The Fahrenheit and Centigrade calculators were separate originally but they have been combined into one calculator now. The name centigrade has been changed to Celsius by international agreement.

Fahrenheit (Form 7230)
When Q is 0.286, set the observed pressure ratio on Scale D opposite arrow 2. READ Dewpoint temperature on Scale E opposite the thermometer temperature on Scale F.

When Q is not 0.286, SET arrow 1 opposite the observed pressure ratio on Scale A. Opposite the correct Q value on Scale C, read the equivalent pressure ratio on Scale B. SET arrow 2 opposite this equivalent pressure ratio on Scale D. READ the Dewpoint temperature on Scale E opposite the thermometer temperature on Scale F.

Celsius (Centigrade) (Form 7230A)
When Q is 0.286, SET arrow 2 at the observed pressure ratio on Scale D. Opposite thermometer temperature on Scale F, read the Dewpoint temperature on Scale E.

When Q is not 0.286, SET arrow 1 at the observed pressure ratio on Scale A. Opposite the correct Q value on Scale C, read the equivalent pressure ratio on Scale D. Opposite the thermometer temperature on Scale F, READ Dewpoint temperature on Scale E.

73°F

MAINTENANCE AND SERVICE NOTES

FOR

"ALNOR" DEW POINTERS

Clean and lubricate the "Alnor" Dew Pointer frequently!

1. **Filters** – See Figs. G and H. Check the fiber glass frequently and change it when it begins to darken. Be sure the filter disk and screen are in the internal filter. When testing gas generators, be sure to use the external filter.

2. **Lubrication** – Keep the pump piston lubricated with a good grade of white petroleum (Vaseline). **Do not over-lubricate.** When working with hydrogen the pump piston must be lubricated more frequently.

3. **Bubbles in oil column** – Bubbles in the oil column of the pressure ratio gauge can easily be removed by alternately pumping up the instrument and releasing the pressure. Tilt the instrument forward or to the left during this operation because this will help remove the bubbles.

4. **Refilling Oil Well** – If the oil is accidentally blown out through the gauge valve (see paragraph No. 9, Ratio Gauge) additional oil can be added.

   a. Be sure the purging valve is open, operating valve up (plunger pulled out) and there is no flow to the instrument.
   b. Remove the knurled knob on the filling well and unscrew the needle screw. Use a small screw-driver to fit the filling well.
   c. Place the unity adjuster in its mid position.
   d. Tilt the instrument to the left.
   e. Depress the gauge valve, **and at the same time** add oil by means of the eye dropper provided, until the column comes up to the 1.0 mark. Hold the dropper firmly in the filling well. Release the gauge valve before removing the dropper. Be sure that the needle screw is tightened in place before attempting to use the instrument.
   f. The manometer oil supplied has a specific gravity of .834. Any other grade oil having approximately the same specific gravity can be used because the density of the oil is not a major factor in the calibration of the Pressure Ratio Gauge.

5. **Leaks** – To operate satisfactorily, the "Alnor" Dew Pointer must be free from leaks.

   a. Check all connections. The purging valve can be reseated by tightening the needle point into the seat. Wear on the operating valve packing can be taken up by tightening the top cap. Check the fog chamber window and lens cap.
   b. If after checking all connections and parts, the oil column in the pressure ratio gauge still should drop, the fault may be in the double acting pump.

6. **Pump** – The pump is designed so no outside atmospheric pressure can interfere with the pump action and only the gas to be tested will go through.
   a. The pump is provided with 4 valves (see fig. F). The inlet valve (from filter) and the outlet valve (to operating valve) are the main valves. If dirt or any other foreign particles accumulates in any one of these valves, the pump will not work properly.
   b. To check inlet valve (valve from filter) set oil column to 1.0 mark. Pump 10 full strokes and the oil column should come above .45 mark. If it takes more than 12 full strokes, the diaphragm could be damaged (stretched) or the inlet valve could be faulty. Loosen nut, carefully bend tubing to one side, unscrew valve screw, remove rubber seat, plunger and spring and clean all parts. If any of these parts are damaged, they should be replaced. Placing the parts back again, be sure to follow figure F. The valve screw should be tight.
   c. To check outlet valve (to operating valve) pump up the pressure to approximately .4 mark, observe the oil column, if there is a slow drop of the oil and after depressing the operating valve, even a faster drop, the fault will be in the outlet valve. Proceed in the same manner as on the inlet valve, when replacing the parts again, be sure to follow figure F.
   d. Keep the pump piston and "O" ring lubricated, and if necessary replace "O" ring.

7. **Operating Valve** – The operating valve generally requires little maintenance aside from occasional tightening of the top cap. If it is necessary to disassemble the valve be sure to follow figure C carefully when reassembling. Lubricate all parts with petroleum jelly before reassembling.

8. **Fog Chamber** – Keep window and lens clean. If necessary replace gaskets. Should the fog chamber become dirty and corroded, the instrument should be sent to the manufacturer for general cleaning, repair and recalibration.

9. **Ratio Gauge** – If the oil is accidentally blown out through the gauge valve, the gauge valve should be washed with naphtha or alcohol. Remove manometer push button by using wrench. To unscrew manometer valve, use two small screw drivers and remove valve. When replacing the valve be sure the "O" ring is in place. Leaks at the unity-adjuster can be corrected by replacing the two "O" rings or the complete adjuster. See figure E. Because of the high coefficient of expansion of the manometer oil frequent readjustment to the 1.0 mark is quite normal if the temperature is changing.

10. **Reservoir** – If diaphragm is damaged (usually stretched) the oil column in the pressure ratio gauge will not come up to the right pressure and excessive pumping becomes necessary and the correct Dew Point can not be obtained. The diaphragm is a Mylar Film. This material is very tough and it is most improbable that a rupture will occur. However depressing the gauge valve when the instrument is under pressure, may stretch the diaphragm. This may also result from pumping when the operating plunger is depressed. If this happens the diaphragm must be replaced. In most of these cases, the instrument should be sent back to the manufacturer for cleaning and repair.

11. **OXYGEN SERVICE** – Special materials are used in Dew Pointers for testing pure Oxygen. Manometer fluid, dibutyl phythalate (Union Carbide Co.) Lubricant, Fluorolube grease GR-362 (Hooker Chemical Co.)
"O" rings in pressure ratio gauge are Parts #7068A, #7086A, #7119B, made of Thiokol (See Fig. E.)

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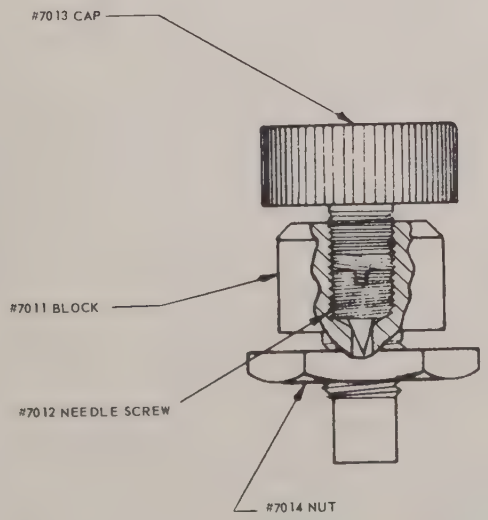
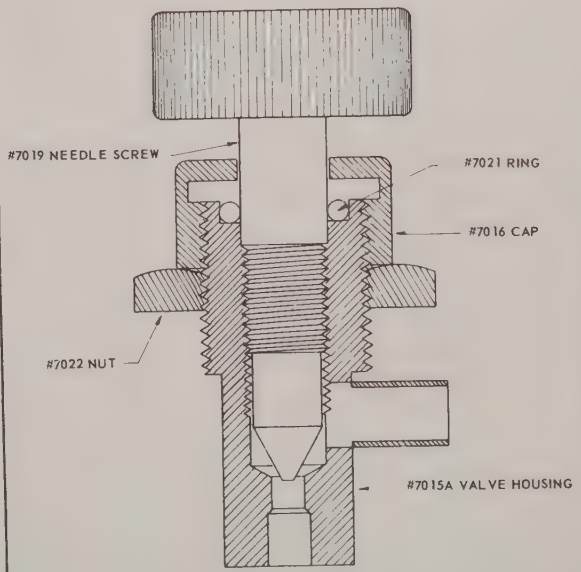
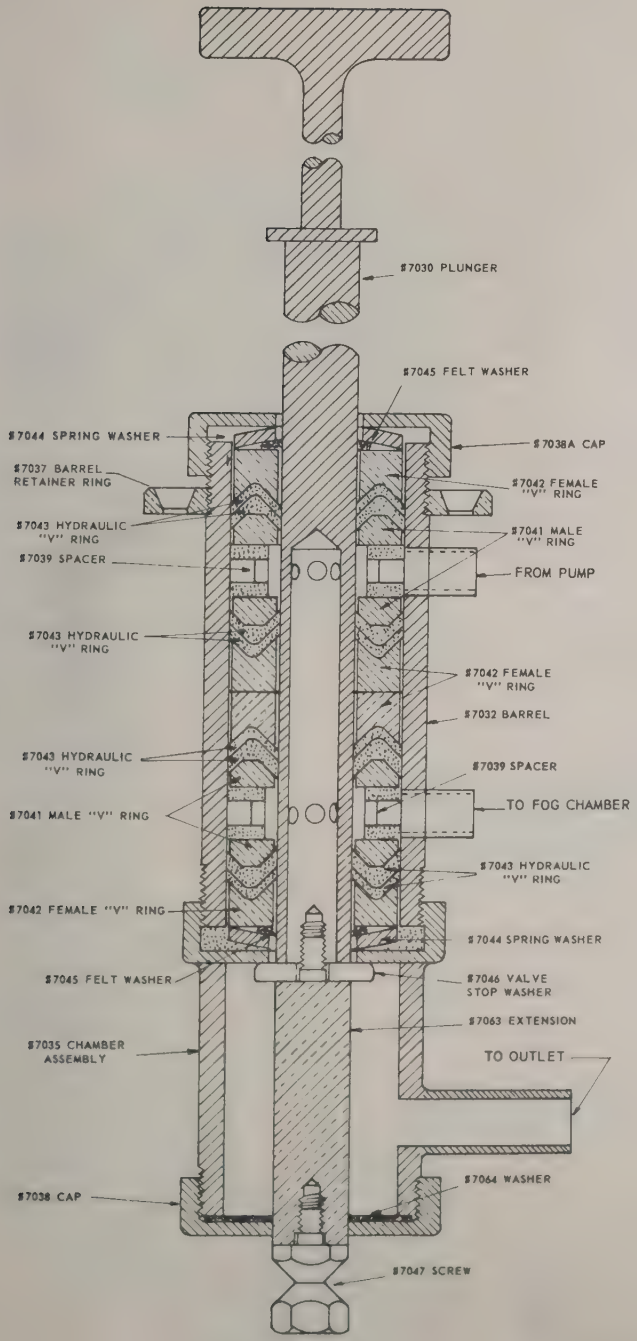


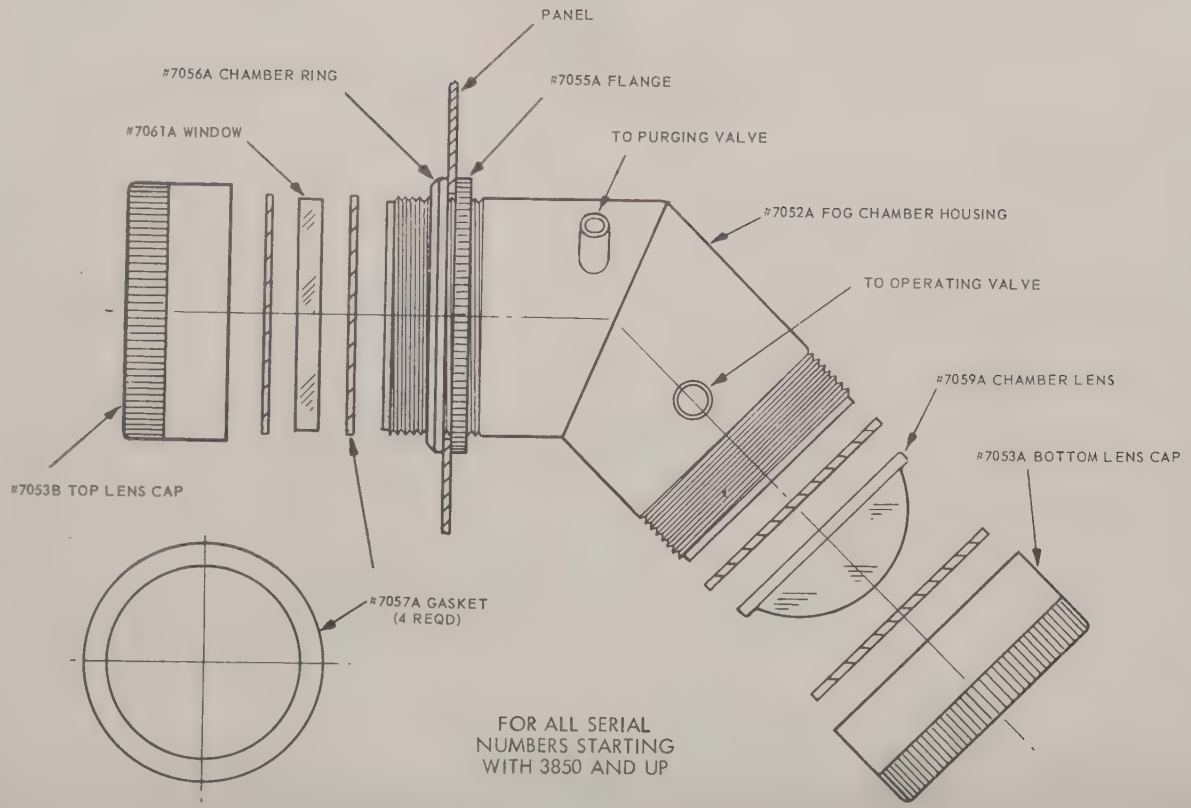
OIL REFILL ASSEMBLY #7010
FIG. A



PURGING VALVE ASSEMBLY #7020
FIG. B

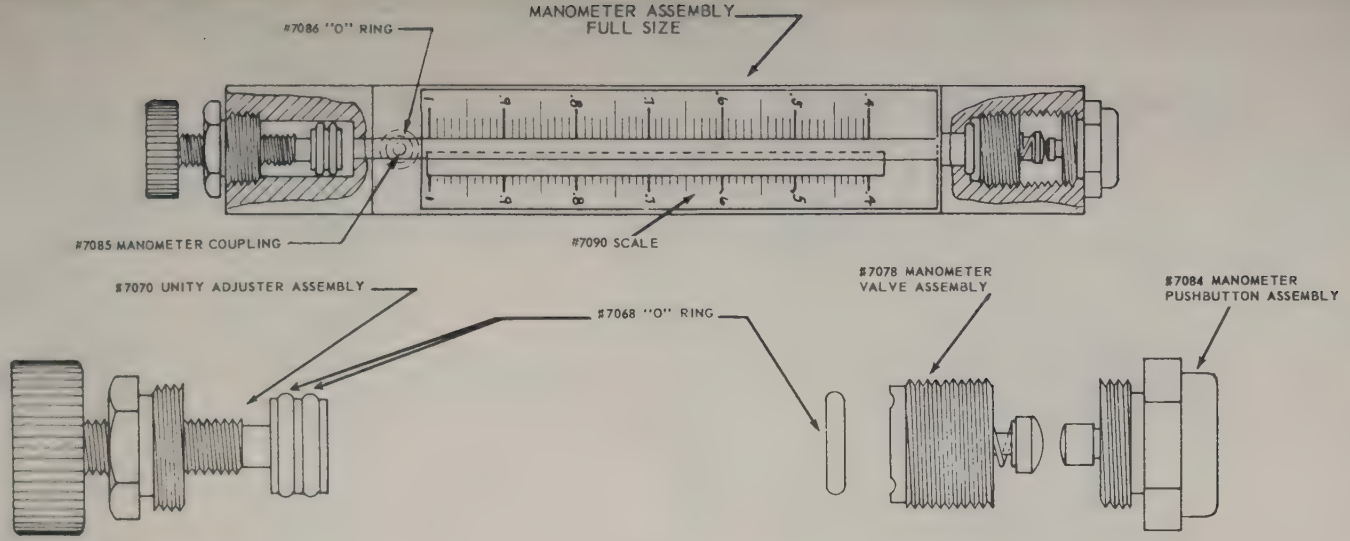


OPERATING VALVE ASSEMBLY #7040
(when ordering, specify type & serial no.)
FIG. C

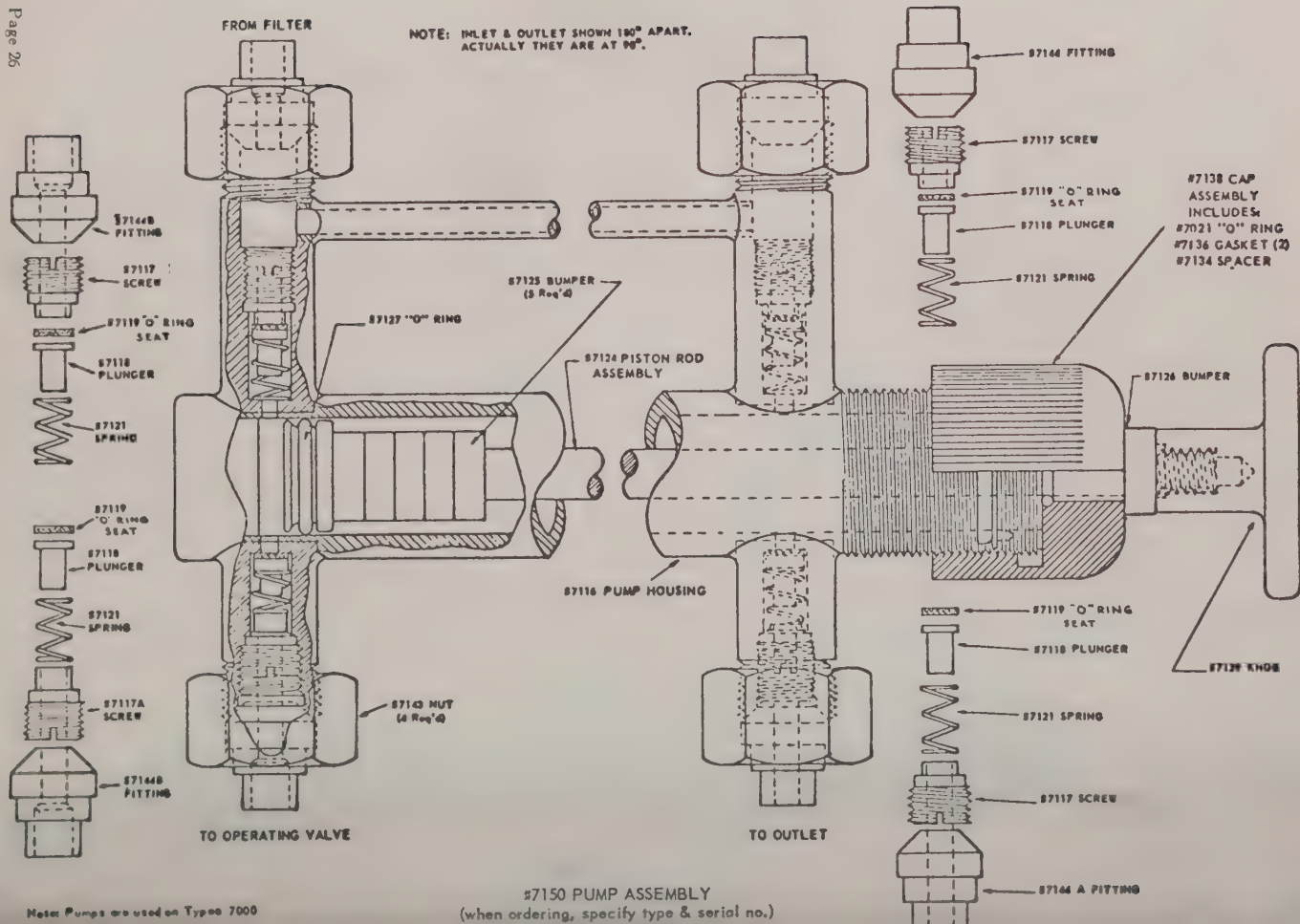


FOG CHAMBER ASSEMBLY #7060A
(when ordering, specify type & serial no.)
FIG. D

NOTICE: FIG. D-1
APPLIES WHEN
SERIAL # IS 3850
OR HIGHER



#7065 RATIO GUAGE ASSEMBLY
(when ordering, specify type & serial no. - h, u, or l)
DOUBLE SIZE
FIG. E



Note: Pumps are used on Types 7000

#7150 PUMP ASSEMBLY
(when ordering, specify type & serial no.)

FIG. G

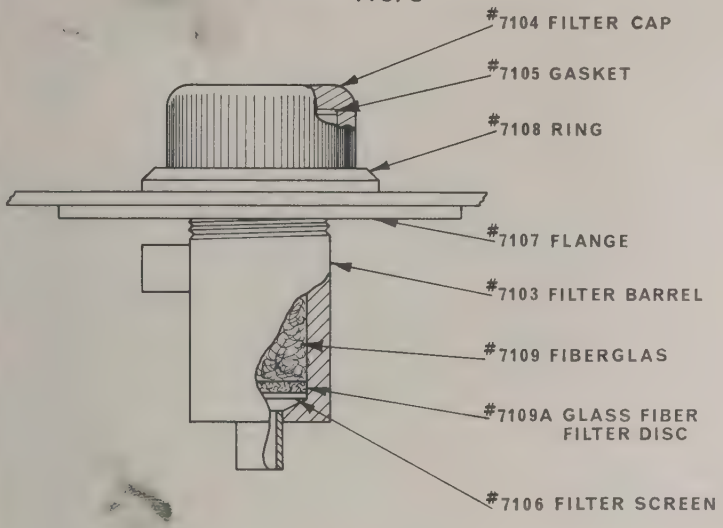
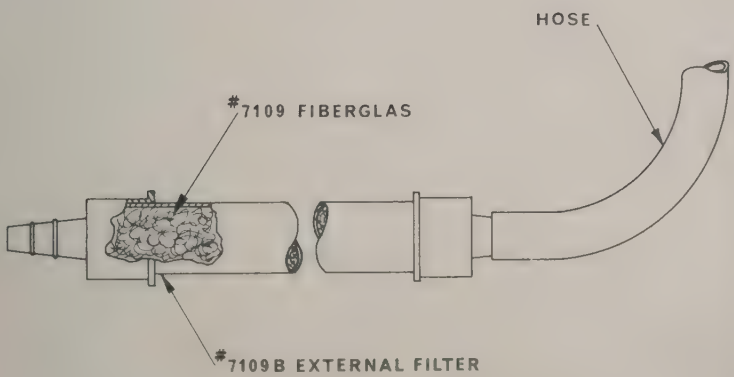

#7104 FILTER CAP
#7105 GASKET
#7108 RING
#7107 FLANGE
#7103 FILTER BARREL
#7109 FIBERGLAS
#7109A GLASS FIBER FILTER DISC
#7106 FILTER SCREEN

FIG. H


HOSE
#7109 FIBERGLAS
#7109B EXTERNAL FILTER

TROUBLE SHOOTING CHART

FOR

"ALNOR" DEW POINTER

OBSERVED DEFECT	PROBABLE FAULT	REMEDY
Oil drops in Pressure Ratio Gauge while under steady pressure	Leaks in system or Leak in pump outlet valve	See Paragraph 5 See Paragraph 6c
Oil rises in Pressure Ratio Gauge while under steady pressure	Leak in Pressure Ratio Gauge Valve	Replace Pressure Ratio Gauge Valve
Pump does not operate freely	Lack of Lubrication	Lubricate pump piston See Paragraph 2
Excessive pumping required	Restriction in supply to Dew Pointer or Diaphragm damaged	Remove Restriction See Paragraph 10
Oil must be replaced frequently	Leak at Unity adjuster	Replace "O" Rings on Unity Adjuster See Paragraph 9

Replace Filter Material Frequently.

Parts List for Alnor Dew Pointer Type 7000

NOTE:
When ordering spare parts always give the serial number and the type number of instrument for which parts are needed.

Number of Part or Assembly	Description
7009	Inlet Fitting
7010	Oil Refill (See Fig. A.)
	7012 Needle screw (for 7010 only)
	7013 Cap (for 7010 only)
	7014 Nut
7020	Purging Valve (See Fig. B.)
	7015A Valve housing — 5,50
	7016 Cap (for 7020 only)
	7019 Needle screw (for 7020 only)
	7021 "O" ring (for 7020, pk of 6)
	7022 Nut
7040	Operating Valve (See Fig. C.)
	7030 Plunger
	7032 Valve barrel
	7035 Chamber
	7036 Flange
	7037 Ring
	7038 Cap (unplated)
	7038A Cap (plated)
	7039 Spacer (pk of 2)
	7041 "V" ring (male, pk of 8)
	7042 "V" ring (female, pk of 8)
	7043 "V" ring (hydraulic, pk of 8)
	7044 Spring washer (pk of 4)
	7045 Felt washer (pk of 4)
	7046 Stop washer
	7047 Switch screw
	7063 Extension
	7064 Gasket
7060A	Fog Chamber
	(See Fig. D-1; S.N. 3850 and above)
	7052A Fog chamber housing
	7053A Bottom lens cap
	7053B Top lens cap
	7055A Flange
	7056A Ring
	7057A Gasket (pk of 12)
	7059A Chamber lens
	7061A Window
7065	Ratio Gauge Assembly*
	(See Fig. E.)
	7062 Manometer block*
	7068 "O" ring (pk of 12)
	7070 Unity adjuster
	7084 Pushbutton assembly
	7078 Manometer valve assembly
	7085 Manometer coupling
	7086 "O" ring (pk of 12)
	7092 Scale assembly*
	7168 Tubing

*When ordering, specify "U", "H", or "L".

7101	Reservoir Assembly
	7096 Reservoir
	7098 Reservoir cover
	7099 Diaphragm (pk of 6)
7110	Filter Assembly (See Fig. G.)
	7109A Filter disk (pk of 100)
	7109B External Filter
	7104 Filter cap
	7105 Filter gasket
	7106 Filter screen
	7235 Fiberglas (boxed)
	7107 Flange
	7108 Ring
7150	Pump Assembly (for 7000 only; S
	Fig. F; S.N. 1800 and above)
	7116 Pump housing (with valve
7120	Spare Parts Group for 7150
	3, 7117 Check Valve Screws
	1, 7117A Check Valve Screws
	12, 7118 Check Valve Plungers
	12, 7119 Check Valve Seats
	12, 7121 Check Valve Springs
	6, 7127 Piston "O" rings
	7124 Piston rod assembly
	7125A Piston bumper (pk of
	7126 Piston bumper

mber of Part or ssembly	Description
	7144 Pump fitting
	7144A Pump fitting
	7144B Pump fitting (pk of 6)
	7139 Pump knob
	7141 Pump flange
	7142 Pump ring
	7143 Fitting nut (pk of 4)
38	Pump Cap Assembly
	7134 Spacer
	7136 Cap gasket (pk of 6)
	7021 "O" ring (pk of 6)
scellaneous Parts.	
	7151 Thermometer shield
	7152 Thermometer base
	7153 Thermometer protection tube
	7154 Thermometer 40°F to 120°F
	7154A Thermometer 0°C to 50°C
	7154B Thermometer -30°F to 110°F
	7176 Toggle switch S.P.D.T.
	7177 Toggle switch D.P.D.T.
	7199B Panel wiring assembly (for 7000 & 7200)
	7199A Case wiring assembly (for 7000 & 7200, less 7220 cable assembly)
	7190 Mercury Switch Assembly
	7186 Switch Spring Assembly
	7189 Mercury Switch
	7192 Hose nipple connector with 7143 nut
	7193 Tubing nipple connector with 7143 nut
	7203 Lamp arm bracket
	7204 Lamp bracket
	7205 Lamp socket
	7206 Lamp, 6-8 volt (pk of 2)
	7207 Lamp protection bracket
	7210 Transformer
	7211 Battery
	7212 Battery plug (male)
	7213 Battery bracket
	7216 Twist-lock base
	7219 Plastic tubing (3 ft.)
.	7220 Cord set
	7229 Wrench
	7230B Calculator
	7231 Manometer oil (4 oz.)
	7235 Filter fiber glass (1 box)
	7202 Case for 7000 Series (give Serial No.)

273 6550

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